Boat markings

Stakeholder discussion has identified "boat markings" as a possible impact from boating use. If canoes or kayaks hit rocks, a small mark the color of the boat can occur. This appears to be framed as an aesthetic rather than ecological impact; for some users, marks on rocks diminish the "naturalness" of the river setting.

It is difficult to quantify the number or locations of boat markings or the proportions of non-boaters likely to see them if boating were allowed. This would probably depend upon boating use levels, the types of boats used, the flows boated (trips at higher flows would probably mark fewer rocks, and the abrasiveness of rocks (smooth or slippery ones are much less likely to be marked). If a certain level of boating occurs, susceptible rocks will likely have become marked, so additional use may have less effect. This impact does not appear to be a substantial concern on other rivers with whitewater use, and we have not seen it discussed in the literature or at river management symposia. Relative to trail impacts, camp impacts, or social impacts such as encounters or conflicts, it is probably minor.

Biophysical impact conclusions

Taken together, information in this chapter suggests several general conclusions about biophysical impacts:

- There are biophysical trail and site impacts on the Upper Chattooga from current uses, but unacceptable impacts can probably be addressed with trail and site design, rehabilitation projects, and more regular clean-up (all of which may present administrative and budgetary challenges).
- Literature on wildlife-related impacts suggests more specific analyses after key species, habitats, and potential recreation impacts to those species and habitats have been identified. It appears unlikely that recreation will have population-level effects, and unacceptable smaller-scale impacts can probably be addressed with education or regulation strategies that encourage low impact behaviors.
- Many biophysical impacts are related to pioneering users, so potential "new" uses such as boating deserve attention and monitoring.
- Many biophysical impacts are addressed with "technical fixes" (site hardening or changes that direct use to non-sensitive or more durable areas) or education/regulation (encouraging people to adopt better "low impact" practices). It is relatively rare (because it is usually less effective) to address biophysical impacts through use limits.
- As a potential new user group, non-motorized boaters are unlikely to camp from their boats, would mostly use existing trails at access points, and represent a low level disturbance to wildlife. However, they would probably create a small number of portage and attraction site trails, contribute litter proportional to their numbers, and utilize car-accessible dispersed or developed camping sites. ,

6. Social Impacts

This chapter examines social impacts from existing or potential recreation uses. For each type of impact, it describes (1) the range of likely impacts on the Upper Chattooga (if known), (2) potential standards to consider in the LAC / NEPA process, and (3) lessons from research or management about addressing these impacts.

Introduction

Social impacts refer to effects visitors have on each others' experiences; examples include encounters, perceived crowding, competition for fishing water, noise levels at a campground, or conflicts between recreation groups. A chapter of the literature review (Berger, 2007) focuses on social impacts and conflict issues, reviewing general knowledge, types of impacts and conflict, and ways that managers typically address them. Specific impacts are described in the "impact by impact" sections below; general findings include:

- Recreation use can affect experiences in many ways. Considerable work has focused on interaction impacts such as encounters, but competition and interference impacts are also important. Signs of use impacts (litter, human waste) were addressed in the biophysical impacts chapter.
- "Normative" research examines evaluations of social impacts; it provides a framework for collecting and organizing evaluative data. Normative methods explore individual evaluations, aggregate responses for groups, and the level of agreement within and between groups.
- Early research focused on encounters in backcountry settings, where encounters were low, users could count and remember them, and encounters have important effects on solitude. Encounter norm research in higher density frontcountry settings shows more variation in tolerances for interaction impacts.
- Norm research methods have been applied to a diversity of impacts, including spacing between anglers, number of people in a viewscape, percentage of time within sight of others, incidents of discourteous behavior, competition for fishing areas, waiting times at rapids and boat launches, and amount of angler interference (Shelby & Vaske, 1991; Shelby et al., 1996, Manning, 2007).
- Social impact research generally recognizes differences between preferences (a more stringent standard) and tolerances (a less stringent one). Expectations are a third variable distinct from, but related to both preferences and tolerances.
- Different user groups may have different concerns or tolerances for impacts in different settings within a recreation area (Manning, 2007). Tolerances can vary for the same person depending upon the setting or timing of an impact. Recreation planning requires impact and tolerance information to be organized for relevant settings, opportunities, and groups.
- Unlike most biophysical impacts, relationships between use and social impacts are often linear, so use limits may offer a powerful management strategy for addressing them (Shelby & Heberlein, 1986). Other strategies include education efforts that help users match their expectations with likely impacts, or education / regulation efforts that help reduce particular behaviors that exacerbate competition or interference impacts.

- Use conflict refers to situations where the presence or behavior of one group interferes with or decreases the quality of another group's recreation. Conflicts between different recreation users are among the most challenging management issues in outdoor recreation settings. When asked to rate the importance of different types of impacts, users often rank conflict-related issues as high as development and signs of use impacts. In many cases, they are rated more important than crowding-related impacts. Additional discussion of distinctions between capacity and conflict is provided in Chapter 8
- Considerable research has documented conflict between different groups (e.g., backpackers and horse users, motorized and non-motorized boaters, skiers and snowmobilers) in a variety of settings, describing characteristics of sensitive and insensitive groups, and predicting when conflicts are likely to be greater. A common finding is that conflicts are asymmetric (one group is sensitive to the impacts of the other, but not the reverse).
- Most efforts to reduce recreation conflicts focus on 1) separating uses by space or time; 2) using "technical fixes" to reduce objectionable impacts; 3) educating users about impact issues to minimize behavior-based problems; or 4) developing new "norms" that support shared use (see additional discussion in Chapter 8).

Encounters

Encounters refer to contacts between groups, and can be distinguished by type of groups (e.g., anglers and boaters, hikers and anglers), timing (e.g., season, weekend/weekdays), and location (e.g., on the river, on trails, in camps, or at attraction sites). Encounters are a common social impact indicator for backcountry settings and they have received considerable attention in the recreation literature. Key concepts and findings from this literature include the following:

- Encounters are important to many river users, particularly in lower use, wilderness-like settings (Vaske et al., 1986; Shelby et al., 1996, Manning, 2007).
- As encounters increase, perceived crowding increases (Vaske & Donnelly, 2002).
- Measuring actual encounters is challenging (Shelby and Colvin, 1982). Few studies measure actual encounters, and most rely on user reports ("reported" or "perceived" encounters). Numbers of encounters reported by visitors are generally lower than actual encounters recorded by trained field technicians. When encounters are over five per day, reported encounters may underestimate actual encounters by about half. Explanations may include cognitive filtering and the perception-recall process, or the lack of distinction between "unique" (contact with a new group) and "repeat" encounters (Shelby & Colvin, 1983; Hall & Shelby, 2000; Whittaker, 2003).
- Measuring encounter standards is also challenging (Manning et al, 2002; Hall & Roggenbuck, 2002). Encounter preferences are generally lower than tolerances for a given type of experience (Manning et al., 2002; Manning 2007).
- Not all encounters have equal effects on quality (Cole, 2001; Cole & Stewart, 2002;). There may be differences for encounters that occur at different times and locations, or with different types of groups.
- The effect of encounters varies for different users. Some are more solitude-seeking and therefore sensitive to encounters, while others are more gregarious, even in wilderness-like settings (Patterson & Hammitt, 1990; Jonas & Stewart, 2002). Information about the likely level of encounters for a setting may influence expectations, which interact with preferences and actual encounters to influence effects on trips (Shelby et al., 1983).

- Even with stable use levels, the number of encounters may vary by day or by trip, so it makes sense to focus on average encounter levels (usually per day).
- Studies in wilderness and backcountry settings show agreement among users that encounter levels should be low (Vaske et al., 1986). In general, wilderness preferences are for fewer than 2 or 3 encounters with other groups per day, while tolerances are slightly higher, about 4 or 5 per day. For less primitive backcountry experiences encounter tolerances are higher still, but usually less than 10 encounters per day.
- For camp encounters, numerous studies have shown that backcountry users prefer to camp out of sight and sound of others (and that camp encounters are generally more important than river or trail encounters).
- Compared to river or trail encounters, camp encounters (camping within sight or sound of another group) usually have lower correlations with use levels because the geography and popularity of individual sites play a larger role (Shelby & Colvin, 1982).

Existing impacts and evaluations

Some research has examined encounter impacts, tolerances, and preferences on the Chattooga, although not usually with enough specificity to distinguish between types of encounters, or group, seasonal, or weekend/weekday differences. Key findings include:

- Most Ellicott Wilderness users are not particularly sensitive to trail encounters (Rutlin, 1995). Only 15% reported disliking trail encounters (23% liked to see other hikers and 61% were neutral). In contrast, many are sensitive to camp encounters (58% dislike "seeing others while in camp") or encounters with loud groups (76%).
- Ellicott Wilderness users prefer low levels of encounters (similar to other wilderness users), but their tolerances are not quite as stringent (Rutlin, 1995). Average preferences were less than 4 other groups at the trailhead, 3 on the trail, and 1 in camp. Average tolerances were 9 groups at the trailhead, 7 on the trail, and 3 in camp.
- Actual encounters reported by Ellicott Wilderness users were in between their preferences and tolerances, with about 6 groups at the trailhead, 4 on the trail, and 2 in camps.
- The 1995 Ellicott Wilderness study did not distinguish data by season, day of the week, or different types of users (e.g., anglers, day hikers, or backpackers/campers). Given the use patterns discussed in Chapter 4, encounters on weekends and in summer and the fall color season are likely to be considerably higher than weekdays, but there are no data to quantify this. Interestingly, the study did not sample users in winter because use levels were too low to cost-effectively administer the survey.
- No other data from Chattooga studies directly address encounter impacts, but studies of lower river boaters (Dye & Burnett, 1994) indicate some boater interest in solitude (even though they experience higher use densities than we expect on the Upper Chattooga if boating were allowed). Several Lower Chattooga management strategies (particularly commercial boating regulations that limit and space commercial trips through the day) are designed to minimize encounters between boaters.
- The number of encounters between boaters and other users (hikers, swimmers, anglers) is difficult to estimate. Actual encounters are based on several variables including the type and enforcement of management actions (if there are use limits, how well do users comply?), the travel patterns of the different groups (especially the timing of their use), how groups behave

when encountering each other (do some try to avoid close contact?), and vegetation and topography (can they see each other?).

- Without a recent user survey of Upper Chattooga users (previous studies have focused on Ellicott Wilderness users and Burrells Ford campers), assessing the relative number and effects of different types of encounters is challenging. However, based on available information, it is possible to draw some conclusions about different types of encounters:

  Encounters ***between hikers on trails*** (including both day hikers and backpackers) are likely to be the most common encounters in the Upper Chattooga, but they are probably less important to trail users than some other impacts.

  - Hikers represent the highest use group on the trails, and encounters among them are likely to be high because they travel the same routes and use the same areas. Although use data suggest summer use by frontcountry anglers and general recreation users can also be high, those groups use of designated trails less often. Backcountry anglers also have relatively lower use levels and do not always use designated trails (preferring user trails closer to the river in some areas).
  - The highest encounter periods among hikers will be during summer and fall color weekends. However, off season and middle of the week periods may offer noticeably low encounters that managers may want to maintain.
  - Based on the (perhaps dated) 1995 study, current trail encounter levels appear to be acceptable and less adverse than other impacts (biophysical impacts, camp encounters).

  Encounters between ***backcountry anglers and hikers*** are likely to be relatively low and less adverse than other encounter impacts.

  - Hikers are more likely to use designated trails, which are often separate from the riverside user trails preferred by anglers. For example, Nicholson Fields (DH) anglers usually travel along the user trails on both sides of the river, while hikers use the designated trail that is parallel but usually out of view.
  - Anglers generally use trails to get to fishable water, but spend most of their time at the river rather than on trails where encounters occur.
  - In the Ellicott Rock reach, where designated trails are closer to the river, backcountry angling use is lower than downstream.
  - The highest use periods for hiking (warm mid-summer weekends) are not usually a high use period for backcountry angling. Both groups are likely to have high use levels during fall color season.
  - From an angler perspective, seeing hikers on the route to a fishing location is likely to have smaller adverse effects than encountering other anglers on the river (an angler-angler encounter, which is related to fishing competition), even though anglers are likely to feel some kinship with other anglers. Hikers are unlikely to distinguish between encounters with anglers or other hikers when encounters occur on trails.

  Encounters between ***hikers and boaters*** (if boating were allowed) are likely to occur more frequently in some parts of the corridor compared to others. The impact of an encounter is also likely to vary, depending upon when and where the encounter occurs, and individual tolerances of the parties involved. Based on the following, many of these encounters may have similar effects as trail encounters with other hikers or anglers (although for some individual boaters or hikers, they could be more adverse).

- As with angler-hiker encounters, boaters travel on the river, while designated hiking trails are often out of view of the river so contact between the two groups may be limited. To estimate the proportion of trail that is separated from the river, the Forest Service calculated the extent of designated and user-created trails within 100 feet of the river (a conservative estimate of when it is possible to see the river through vegetation). In the Upper Chattooga, about 26% of designated trails and 51% of user created trails are within 100 feet of the river. In many if not most cases, encounters between hikers and boaters will be "brief sightings" through the trees.
- Boating use (if allowed) is likely to be highest on winter and early spring days immediately following storm events, which are relatively rare (see Chapter 7). Some proportion of those days will be rainy and cold, lowering hiking and backpacking use, and reducing the chances of boater-hiker encounters.
- If whitewater boating is allowed, boaters are also likely to spend more of their time in the parts of the river with more difficult rapids, which tend to be the steeper reaches where designated trails are farther from the river. On lower-gradient sections, whitewater boaters are likely to pass by quickly. This will reduce the number and length of boater-hiker encounters.
- Geography and timing can interact to affect the likelihood of boater-hiker encounters, particularly when hikers have left designated trails to get to the river (e.g., to relax, picnic, or camp). For example, if a site is near the boater put-in and hikers reach the area after mid-day, boaters are likely to be downstream and no encounter would occur; if a site is at the end of the reach and it is near the end of the day, boaters are likely to pass by).

Encounters between ***anglers and boaters*** (if boating were allowed) could be high on the days when flows are acceptable for both, but several variables affect the number and effects of these interactions. When they occur, these encounters are likely to be adverse for anglers, but less so for boaters.

- Boater and angler use are related to the frequency of days with acceptable or optimal flows, a complex topic addressed in Chapter 7. In general, flows too low for boating or too high for angling would produce few boater-angler encounters. In between, there are two "overlap ranges" where both activities occur and encounters might be high for some segments. In one overlap range, angling is optimal but boating is only "acceptable;" in the other, the converse is true.
- Because anglers spend most of their time near the river, and usually fish a small segment of the stream, they are likely to be passed by nearly all the boaters using the segment on that day (unless there is a timing differential; see next bullet). This is a major difference from hiker-boater encounters, which are less likely to occur because the two travel in different areas (one on the trails, the other on the river).
- Timing affects the number of angler-boater encounters. In general, boating occurs in the middle of the day due to the logistics of arranging shuttles, preparing gear, and taking advantage of warmer weather. In contrast, timing for anglers vary through the year. For example, the best fishing in summer is early morning before temperatures have risen; in winter, the best times are the middle of the day when the sun has raised temperatures slightly; in the spring and fall, there are typically better periods in morning and late afternoon, but some months offer uniformly good conditions throughout the day (see further discussion under fishing interference impacts below; also Berger, 2007). Based on this information, angler-boater encounters are more likely to occur in the winter

months (December thru February) when both groups are on the river in the middle of the day (although angler use levels for some reaches may be lower during those months). As the weather warms by mid-March and April, boating concentrated in the middle of the day would likely produce relatively fewer boater-angler encounters.

- Geography and timing can interact to affect the likelihood of encounters, as with hikers. Anglers that fish near the start of a boating run in the first half of the day will probably see most of the boaters that might launch that day; if they fish the same location in the afternoon, they may not see any.
- Some boaters may avoid the Nicholson Fields (DH) reach when boating from Burrells Ford, because this lacks challenging whitewater and there is a take-out option via Lick Log / Thrifts Lake trail. This take-out also shortens the length of the run (which is otherwise long for a day trip) and the shuttle. However, it is only likely to be used by kayakers (it is a long uphill carry for a canoe or raft).
- Taken together, we believe angler-boater encounters are among the most important impacts associated with allowing boating use on the Upper River. Several other studies of angler-boater encounters have shown that anglers can be very sensitive to this impact (Heberlein & Vaske, 1977; Manning, 1979). In some studies, encounter tolerances were as low as 2 groups per day, although in others tolerances have been as high as 7 per day.

Encounters between ***swimmers/frontcountry recreation users and boaters*** (if allowed) are likely to be rare and do not represent a substantial impact.

- As discussed above and in Chapter 7, boatable flows are more likely to occur outside the summer season when temperatures are too cool for most swimmers. Although a stakeholder demonstrated it was possible to swim during the January 2007 expert panels, few people are likely to swim outside summer months.
- Swimming occurs at relatively defined locations (particularly Sliding Rock, Bull Pen Bridge, and Burrells Ford) that boaters are unlikely to use at typical summer flows. For example, unless the segment through Whiteside Cove is adjudicated "navigable," Sliding Rock does not offer access to the rest of the river and is unlikely to be used by boaters (it is not a good playboating location). Conversely, Bull Pen Bridge is not a safe place to swim at boatable flows, and it is not boatable at swimming flows.
- Even at locations in the lower river (e.g., Bull Sluice Rapid) where swimmers and boaters commonly interact (and boating use is much higher than is likely on the Upper Chattooga), there appear to be few interference impacts as long as boaters and swimmers behave responsibly and communicate; addressing these sorts of problems is usually accomplished through education efforts (Hedden, 2006).

Boater-boater encounters have not received much attention during stakeholder discussion, but could be a relevant impact if boating were allowed. While there are no data about boater preferences or tolerances for encounters on the Upper Chattooga, there is limited information about these for the Lower River (Sections 3 and 4). In general, private boaters on those sections prefer to see less than about 20 other users per day, but would tolerate as many as many as 40 to 50; current averages suggest they see about 20 to 30, with at least half of those being commercial users (Dye & Burnett, 1994). Public meeting comments and expert panel fieldwork suggest potential upper river boaters are interested in a lower density boating opportunity compared to the lower river.

Camp encounters refer to the percent of nights spent in sight or sound of another group and are only relevant for groups that camp (generally backpackers, but some backcountry anglers

may camp as well). They are likely to be a very important impact for campers, and they interact with camping competition impacts described in a separate section below.

- Camp encounters are likely to be related more to the geography of specific camps than use levels, as on other rivers. There are several clusters of backcountry camps (as well as the developed walk-in campground at Burrells Ford) and those who occupy them will usually camp within sight or sound of others. Other sites (about 15 of the 97 on the upper river) are more isolated. The proportion of sites with more privacy is a potential indicator of the likelihood of camp encounters.
- For the campsites that are in sight or sound of other camps, the open question is how often people will occupy sites in close proximity to others. The 1995 study suggests that campers saw an average of two other groups while in camp, but the survey question wording may not be equivalent to "two groups camped in sight or sound." The estimated peak backpacking use levels are about 10 groups each in the Ellicott Rock and Rock Gorge Reaches, which have 40 and 30 backcountry campsites respectively. Unless these groups tend to camp at the clusters of sites next to each other, they probably are not having encounters with two groups per night (and there are probably other sites where more privacy is available).
- Boating (if allowed) is unlikely to affect camp encounters because very few are expected to camp. Boatable flows often occur for only a day or two, challenging rapids encourage boaters to take as little gear as possible.

Potential encounter impacts and standards

Based on the review of existing conditions and potential user preferences/tolerances, potential encounter indicators include the following:

- Encounters on trails (groups per day).
- Encounters along the river (groups per day).
- Proportion of campsites in sight/sound of other camps.
- Number of groups in sight/sound while camping.

An additional related indicator, "boats passing anglers," addresses both angler-boater encounters and potential interference impacts related to that encounter; it will be examined in greater detail below. The list does not include an encounter measure for frontcountry areas; research indicates that encounters are more difficult to measure and less meaningful to users in higher density settings (Manning, 2007). The two camp encounter indicators do not apply to Burrells Ford, which is a developed walk-in campground.

With each of these encounter-related indicators, standards could be set at one of three levels:

Current conditions/tolerances (based on 1995 study and/or professional judgments that account for potential changes since that study, plus the review above):

- Less than 7 trail encounters per day.
- Less than 3 encounters while at sites on the river.
- At least 15% of backcountry campsites are out of sight and sound of other camps
- Less than 3 groups (on average) in sight/sound while camping.

Improvement from current conditions (professional judgments that attempt to improve the current situation toward user preferences rather than tolerances).

- Less than 5 trail encounters per day.
- Less than 2 encounters while at sites on the river.

- At least 30% of backcountry campsites are out of sight and sound of other camps.
- Less than 2 groups (on average) in sight/sound while camping.

Preferences for more primitive or wilderness-like conditions (based on research from other areas, and professional judgments about conditions that meet user preferences).

- Less than 3 trail encounters per day.
- Less than 1 encounters while at sites on the river.
- At least 50% of backcountry campsites are out of sight and sound of other camps.
- Less than 1 group (on average) in sight/sound while camping.

It is possible to choose different standards to provide different recreation opportunities, although this creates challenges for management and enforcement (see discussion in Chapter 8). Given the uneven use patterns in the Upper Chattooga, less stringent standards might be applied to high use periods (summer and leaf season weekends) and more stringent standards to the off-season and middle of the week.

Addressing encounter impacts

The relationship between use levels and river or trail encounters is well established in linear management units such as rivers, so use limits are probably the most powerful tool for addressing them. However, use limits are a substantial managerial effort, and most of the rivers in the country have not applied them. Just over twenty North American Rivers have full permit systems (limits on both commercial and non-commercial use) although about 50 others appear to have commercial limits or protocols for limiting non-commercial use if capacity standards are exceeded. Similarly, many backcountry and Wilderness areas have permit systems designed to keep encounters low. In most cases, use limits apply to overnight trips, although day use limits is also limited in a few places. Chapter 8 provides additional information about these use limit systems.

It is also possible to limit use indirectly through other actions such as managing the size of access parking lots. Using information to disperse use spatially or temporally may also be effective if there are adequate substitutes. Even if education attempts fail to actually redistribute use, they prepare users for the encounters they will experience, making expectations and tolerances more "realistic."

Unlike trail or river encounters (which are correlated with use levels), camp encounters are usually related to site locations and geography. Management actions such as designating sites out of sight/sound of each other are more likely to reduce camp encounters.

Competition impacts

Encounters involve "just seeing" another group; competition impacts involve contention for potentially scarce resources. Competition for camps or fishing water are common examples. Key findings from this literature include the following:

- "Fishing competition" has been measured as "the percent of time users pass up a desired fishing area because it was occupied." It has been studied at several moderate to higher density fishing areas in Alaska, Oregon, and California.
- Impacts and tolerances for fishing competition have varied widely, but tend to be much higher on Alaskan salmon streams (40 - 50% responses are common) than lower density trout

streams (10 - 20%). In most studies, angler tolerances are slightly higher than the level of impacts they report.

- There are no comparable data for the Upper Chattooga. Fishing competition is probably an issue at the frontcountry fisheries at Burrells Ford and Highway 28 during stocking season (April through October), and for the Nicholson Fields reach during DH season. Based on studies conducted elsewhere and use estimates in this report, current competition levels are probably similar to the lower density trout segments at about 20% (e.g., California's Pit River Canyon, Alaska's Situk River; low use segments and seasons on Oregon's Deschutes).
- A few studies have measured camp competition. Studies on ten rivers in Alaska asked boaters to report the proportion of camps they wanted to use but could not because the camps were occupied, and then compared those impact levels with a parallel question about camp competition tolerances (Whittaker et al., 1990; 1996; 2000). Results showed users were willing to pass up 10 - 20% of camps on wilderness-like rivers and 30 - 50% on less primitive rivers.
- Camp competition is theoretically similar to campsite occupancy rates (number of occupied camps divided by the total number of camps). This, in turn, is related to the density of trips, making occupancy rate a reasonable indicator of camp competition. In Grand Canyon, for example, there are about 200 camps overall but only about 80 "more desirable" camps. At high use times, there are about 60 trips at one time (TAOT), and this "75% occupancy of desirable camps" indicator reflects the camp competition reported by users. However geographical "bottlenecks" exacerbate the issue, making this a less-than-perfect indicator for these areas.
- There are approximately 70 backcountry camps in the Upper Chattooga (not including the 30 camps at Burrells Ford), and total overnight use probably does not exceed 25 groups at one time on peak weekends. This produces a (roughly) 35% occupancy rate.
- On the Chattooga, use estimates suggest there may be as many as 10 overnight groups in the 5 mile Ellicott Rock reach and 10 in the 7 mile Rock Gorge reach during high use times, so densities may range as high as .5 to .7 miles per trip in these reaches. In a review of 25 multi-day wilderness-like rivers, the median density was 2.3 miles between trips (Shelby & Whittaker, 2003), so Chattooga camping densities are generally higher than on many other wilderness rivers. However, during non-peak times, densities are probably less than half as high.
- This campsite occupancy rate does not necessarily correlate with low competition, because the number of "desirable sites" is probably lower. On the Upper Chattooga, there are some higher quality sites near good swimming/relaxing beaches or at a "popular" distance from trailheads, and there is at least one large camping area with multiple sites (confluence of the East Fork). There are probably trade-offs between having a good site and camp encounters. No study has addressed these impacts for the Chattooga, but Appalachian Trail users (Landres, et al., 2005) preferred to see less than three other parties at one time at sites in that moderate to higher density backcountry setting.

Potential competition indicators and standards

Three ***potential competition indicators*** include:

- Percent of fishing areas passed because they were occupied.
- Percent of campsites passed by because they were occupied.
- Percent of camps occupied per segment.

Current conditions/tolerances:

- Less than 20% of fishing areas passed because they were occupied.
- Less than 30% of campsites passed because they were occupied.
- No more than 30% of campsites occupied.

Improvement from current conditions:

- Less than 10% of sites passed because they were occupied.
- Less than 15% of campsites passed because they were occupied.
- No more than 25% of campsites occupied.

Addressing competition impacts

Like encounters, there is probably a linear relationship between competition impacts and use levels (especially in an elongated river corridor). Use limits are one tool for managing them, and several rivers and wilderness areas employ a permit system to keep the number of overnight parties at a level commensurate with the number of camps. In some places, campsites are also reserved to improve efficiency, and decrease competition.

Other management actions (as discussed for encounters above) can also be used. Information about camp sizes and locations can help users choose and make expectations realistic. An inventory would also help identify "bottleneck" areas that may benefit from other management actions.

There is little history of addressing fishing competition on public land with permit systems, with one notable exception in Georgia. Dukes Creek is managed with a limited access system that ensures that no more than 15 anglers. The angling area just over four mile, so it produces low densities and limits encounters and competition (Durniak, 2007). The Nature Conservancy operates a similar limited access program (10 anglers at one time) on a 3 mile reach of California's McCloud River. In both cases, the limited access concept appears to be strongly supported by anglers who value solitude.

On some rivers, regulations of fishing techniques reduce competition between anglers. For example, Alaska's Kenai River and Oregon's Lower Deschutes have "no fishing from a boat" regulations for some reaches to give bank anglers priority. Because all anglers fish from shore, boat-based vs. shore-based fishing competition is prevented. Managers are considering regulations on the West Branch of the Delaware to address competition between shore-based and tube- or canoe-based anglers.

Interference with angling

Interference with anglers impacts refer to potential consequences of angler-boater encounters: boats passing anglers may make anglers move (themselves or their lines) or "spook" fish.

"Making anglers move" is a social impact which is related to several variables: characteristics of the location (e.g., river width, part of the river anglers are fishing, space for boaters to pass); tackle (e.g., spinning gear, which has a longer "range"); behavior of anglers (e.g., bank fishing vs. wading in to the channel); and behavior of boaters (do they know and take the "path of least disturbance?"). For example, during expert panel fieldwork, boaters encountered anglers about a half-mile upstream of Burrells Ford. This was a wide part of the river and boaters chose to pass on the opposite side, well away from where anglers were fishing, although spinning gear could "access" the entire width of the river. Such encounters probably minimize interference with

angling. This would change in narrower locations, if anglers wade farther into the river, or if boaters choose a different route.

"Spooking fish" is a biophysical impact that is sometimes framed in terms of "fish stress" or "health." Research focused on improving the stocks of hatchery fish suggests individual trout vary in their response to "stress," more sensitive fish feed less, and these traits appear heritable (Oliveri, 2006). However, "spooking fish" is more often discussed in terms of effects on fishing success (do passing boats cause fish to stop taking tackle, and if so, for how long?), a topic with less research.

Many natural predators attack fish from above, so fish are likely to be sensitive to disturbances from that direction. Some anglers are careful in how they approach a reach ("being stealthy," trying not to disturb the water while wading or casting, etc.), and anecdotal evidence suggests that boats passing over fish cause them to "spook." However, many high quality fishing rivers have considerable boat traffic (e.g., Blackfoot, MT; Madison, MT; Big Horn, WY; Middle Fork Salmon, ID; Kenai River, AK) and many anglers catch fish while boats pass. The open question is the length of time it takes for fish to return or resume feeding after boats pass.

Requests to several Forest Service or other fish biologists have not produced research addressing the effects of passing boats on population viability, fish behavior or fishing success. Idaho's Upper Main Salmon River is closed to boating during Chinook spawning periods to prevent boating disturbances over shallow gravel bars. One Idaho biologist noted "informal administrative results" showing that passing boats can "disturb and displace spawning Chinook salmon if the interactions occur at close proximity," although "we have no idea at what level these disturbances affect their reproductive success" (Moulton, 2007).

An experiment addressing "fish welfare" suggests trout may experience "fear," and can learn and remember an "avoidance behavior" (but provides no information about how long the fish remained "afraid") (Yue, Moccia, and Duncan, 2004). In addition, this finding seems too general for estimating the length of time a passing boat may cause "diminished fishing" in natural settings, let alone in the specific conditions found on the Chattooga. Instead, we rely on discussions with the angler expert panel and several fish biologists to suggest the length of "diminished fishing." In general, these discussions suggest boats may cause an effect that probably lasts from from a few minutes to an hour (although a few anglers say "the rest of the day"). Variables hypothesized to affect "diminished fishing" include:

- Type of fish (brown trout are more sensitive)
- Hatchery vs. wild fish (wild or naturalized fish are more sensitive)
- Size/flow of the stream (fish in smaller or lower flow streams are more sensitive)
- Water clarity (fish in clearer streams are more sensitive)
- Number and behavior of boaters
- Frequency of boats and the ability of fish to habituate to boating use

Managing the social and biophysical aspects of interference with angling is challenging; this is a "conflict" between recreation uses with many variables, and reviewing the issues in the previous section shows no simple way to totally eliminate negative effects from boater-angler encounters. In higher density situations (e.g., different segments on Oregon's Deschutes River), we have documented angler tolerances for 0 to 3 boats passing ***per hour***. In lower density situations, the impact has generally been examined as encounter tolerances, and tolerances are more on the order of 4 to 6 boats per day (Alaska's Situk River; Whittaker, 2003) or 2 to 7 groups of boats per day (Heberlein & Vaske, 1977; Manning, 1979). Many anglers prefer to fish areas that are not being

used by other recreationists such as boaters (Harris & Bergersen, 1985), but surprisingly little research documents these preferences or associates such preferences with different types of anglers or river settings. .

A related issue focuses on the nature of boater-angler encounters, particularly the extent to which anglers feel that boaters pass discourteously. As with "fish spooking" impacts, there is anecdotal evidence that some boaters pass anglers too closely, move to fast, splash, or are noisier than some anglers prefer, behaviors that may exacerbate the level of interference with fishing. Unfortunately, we have not found any studies that document the extent of these problems, nor angler perceptions toward them.

Following up on stakeholder lists of specific rivers with potential for adverse angler-boater interactions (e.g., Conasauga and Jacks River, WV; rivers in Great Smoky Mountains NP, Cranberry River, WV), we were unable to document the frequency or severity of these types of impacts; in many cases, river planners noted that the two groups used different flows or seasons and rarely interacted. Absence of evidence does not mean these interactions do not occur, but the issue does not appear to have become a management priority on most southeastern rivers.

On several rivers in Montana (e.g., Blackfoot, Ruby, Rock Creek, Beaverhead, Big Hole, and Madison) conflicts between boat-based and shore-based anglers are a management issue, and Montana Fish, Wildlife, & Parks has implemented "no fishing from a boat" regulations to address them. On a few reaches however (particularly the Blackfoot and Rock Creek), scenic rafters, canoers, or tubers are also an issue for anglers, who are largely displaced when boating traffic increases in the middle of the day (Sperry, 2007).

In lower density situations such as the Upper Chattooga, separating uses by space and time are one way to address these types of impacts. For example, the Nicholson Fields reach (DH reach) is highly attractive to anglers but has no whitewater; boaters could take out above the reach at Lick Log Creek (zoning in space) and eliminate encounters. Similarly, the best boating occurs at times when flows are higher, while the best angling occurs when flows are lower (see Chapter 7 for additional discussion); boating only during high flows (zoning in time) eliminates encounters.

There may be times (mid-range flows) when both activities could occur, and it is possible then to limit boating to "zero capacity" (to eliminate encounters). It is also possible to limit boaters to numbers low enough to be tolerated by anglers. Although anglers probably prefer zero boaters, they may tolerate some boat passes if they knew the numbers would be low. Chapter 8 describes some separation/zoning choices that would capitalize on natural use patterns.

Group size and large group encounters

The size of groups affects opportunities for solitude and the character of wilderness trips, as well as group logistics and dynamics. Monz, et al. (2000) reports about 52 percent of wilderness areas have established group size limits; most limits are less than 24, with the median at 12. A review of group size limits on 25 multi-day river systems in the west (River Management Society, 2003) shows that about one-third have limits at 16, and three-quarters have limits of 26 or less.

The Upper Chattooga apparently attracts some large groups (e.g. boy scouts, hiking club outings), but information about the number and their size is anecdotal at best. Although there is no current group size regulation, the recent Forest Plan revision identifies a group size standard of 12 (USFS, 2004). Most groups are much smaller than this (based on survey data), but some

organized groups apparently exceed 20 users. Enforced group size limits may address some biophysical impacts, and they limit "large group encounters," which can affect wilderness character and solitude (Monz et al., 2000).

Trailhead congestion / parking

Access congestion refers to the quantity of people and gear at access points such as trailheads or boat launches, and the way it affects efficient use of facilities (boat ramps, rest rooms, parking). Access congestion has been examined in some river studies, but it appears less important to users than river encounters or camp competition, particularly on multi-day trips (Whittaker, 1993). Users appreciate efficient facilities that can handle the expected volume of use, but a small proportion of the trip is spent at access points, so short-lived congestion is probably tolerable.

Recent studies in the Chattooga corridor did not specifically address congestion problems, but anecdotal evidence suggests it may occur in busy summer and fall color seasons at parking areas for Sliding Rock, the DH reach, and at Burrells Ford. The obvious indicator in these cases is "percent of parking spaces occupied;" and a standard might be set near 100%.
Stakeholder discussion has shown some concern for parking impacts from allowing boating use, particularly at areas where the number of spaces is limited (e.g., Bull Pen Bridge, Highway 28). If boating occurred when other use was high (e.g., peak weekends in summer), this impact is more likely to develop. However, hydrology analysis suggests that boatable flows are far less likely during the summer and fall when hiking and angling use is higher.

Search and rescue impacts

Some stakeholder discussion has focused on potential search and rescue (SAR) impacts associated with allowing boating on the Upper Chattooga. As described in the expert panel reports, all three reaches have at least one Class V and several Class IV rapids, so boaters need appropriate skills and experience. The addition of large woody material from dying Hemlock is likely to add to these risks.

Estimating the number and type of incidents (or the associated SAR impacts) that might occur if boating were allowed is challenging. To address these issues, we consulted a well-known whitewater boating safety expert (Walbridge, 2007), the Lower Chattooga river ranger (Hedden, 2007), a Forest Service summary of Lower Chattooga river fatalities (Forest Service 2007), a North Carolina river manager (Hendricks, 2007), a river ranger on the Big South Fork (Moses, 2007), and the AW river accident database and related reports (Wittman, 2006; Phyler, 2006).

- Walbridge (2007) points out that if boating were allowed on the Upper Chattooga, "there are going to be some accidents, injuries, and eventually a fatality." However, based on likely use levels and information from other rivers of similar difficulty, he estimated that "the number of fatalities or serious accidents due to boating is likely to be low, and a few will require SAR responses."
- A fatality rate calculation for whitewater boating from 35 rivers from 1994-98 suggests about 0.9 fatalities occur per 100,000 user days (Wittman, 2006); 1998 had the highest rate with 1.1 fatalities per 100,000 user days. For kayaking only, the rate was 2.9 fatalities per 100,000, presumably because kayakers boat more challenging rivers than whitewater boaters (including rafters, canoers) as a group.

- Applying the 2.9 rate to our "guesstimate" of about 1,200 user days per year on the Upper Chattooga, a fatality is likely to occur about once every 28 years. This should be viewed as a very rough estimate.
- Specific characteristics of a river can substantially influence fatality rates. Fatality rates may be as high as 1 in 4,000 user days (Class V Russell Fork KY) because of sieve and undercut hazards, or as low as 1 in 1,000,000 (Class IV New River Gorge, WV) where powerful hydraulics may flip boats but rarely cause fatalities (Walbridge, 2007). Walbridge thought the Class IV-V Upper Youghigheny, PA might be a good point of comparison for the Upper Chattooga in terms of difficulty; the first fatality occurred in the past year after about 30 years of higher use than is expected on the Upper Chattooga.
- On Tennessee's Class IV Big South Fork National River, there has been one fatality in about 25 years of regular boating (150 day season, peaks about 100 private boaters per day), but SAR responses are generally required about two times a year (Moses, 2007). The 8 mile gorge segment of this river is similar to the Upper Chattooga with limited road access, which presents some SAR response challenges but impacts from these responses have not been a substantial issue for management.
- The Lower Chattooga has had 23 fatalities since more active safety efforts began about 1975 (Forest Service, 2007). Of these, about one third (8) were associated with kayaking, one third (6) with rafting, and one third (9) with swimming, wading, or hikers crossing the river. Most of these occurred on Section IV in the Five Falls rapids, which have several known hazards. The frequency of similar hazards on the Upper Chattooga is not known. Despite consistent hiking, swimming, and angling use on the Upper Chattooga for at least two decades, there do not appear to have been any fatalities above Highway 28, and SAR responses are rare (Hedden, 2007).
- About half of the Lower Chattooga fatalities apparently required larger-scale SAR responses or body extractions (Forest Service, 2007). SAR squads apparently respond to the river about 6 to 8 times per year (not always for a fatality), although the Forest Service does not track these incidents (Hedden, 2007).
- The AW accident database (2007) identifies two accidents on Overflow Creek (generally considered more difficult than the Upper Chattooga by the expert panel), but apparently neither was a fatality. Walbridge reports that several other boaters have been injured on Overflow, but they have generally walked out or self-rescued. Several sources agree that many non-fatal accidents during whitewater boating are "handled" and never reported; a major factor is the skill and experience in the group (or passing groups). In general, Class IV-V boaters have first aid and swiftwater rescue experience (Walbridge, 2007), but some wonder if this is declining among younger boaters (Hedden, 2007).
- Hendricks (2007) estimated varying rates of SAR incidents on several NC rivers. At the high end of the spectrum, the new flow releases on the Cheoah appear to be relatively more dangerous because of live trees in the channel due to low base flows for several decades; the river has already had one fatality and appears to require a SAR response about every other release. On the other end of the spectrum, the Class II-III Nantahala has only 1 to 2 SAR incidents a season despite very high use (although this is expected to increase as new relicensing flow releases are provided in the more challenging gorge).
- About 60% of boating fatalities occurred when boaters were not wearing a PFD (Phyler, 2006); higher skilled boaters are less likely to boat without such equipment.

- On a segment of the James River in VA, requiring boaters to obtain a permit helped reduce the number of accidents by discouraging less experienced boaters (Robertson, 2002).
- If SAR or body extraction efforts are required on the Upper Chattooga, there may be impacts related to access to the scene for staff and equipment. Wilderness designation complicates the use of some equipment and access, although "minimum tool" analyses and a pre-accident plan with "equipment approval levels" have been developed for other rivers in NC with similar constraints (Hendricks, 2007).

Taken together, the number of accidents, fatalites, and SAR responses will probably increase if boating is allowed on the Upper Chattooga. These responses, in turn, are likely to create some localized or access-based impacts, but these will probably be low.

Social impact conclusions

Taken together, the preceding chapter suggests several general conclusions about social impacts on the Upper Chattooga:

- Some social impacts may be greater than typical standards for Wilderness or more primitive backcountry settings, but existing information does not provide enough detailed information to be sure.
- The recreation literature shows that some of these impacts are probably important to users (e.g., encounters at camps or riverside destinations), but others are probably less important (e.g., trail encounters).
- Although there have been no Upper Chattooga studies assessing the relationship between use levels and social impacts, studies from other locations suggest that use-social impact relationships are often linear. More people entering the trail system will probably produce more encounters and competition, although geography and the thick wooded setting may minimize the effects.
- If boating were allowed, boater-angler encounters and interference with fishing are likely to be the most substantial social impact issues for anglers. There are likely to be fewer encounter problems with hikers, swimmers, or frontcountry users (who tend to use the river in summer when boaters are less likely to be present) and hikers in particular may not see boaters through the heavy vegetation when trails are not immediately adjacent to the river.
- Other social impacts include angler-angler encounters and fishing competition in the DH during DH season, and camp encounter and competition on peak summer weekends.

7. Flow Issues

This chapter assesses flow requirements for fishing and boating opportunities, and applies hydrology information to estimate how often each would be available in an average year (if boating were allowed). It begins with an introduction to flow-recreation concepts, summarizes Upper Chattooga (also known as the North Fork Chattooga) hydrology, reviews findings about flow requirements from the expert panel fieldwork, and summarizes the "frequency of days" analysis.

Introduction

In many river settings, recreation opportunities occupy different "niches" in the flow regime. For example, many studies have documented that anglers prefer lower flows and whitewater boaters prefer higher ones (Whittaker, Shelby, & Gangemi, 2006; Whittaker, Shelby, & Abrams, 2006). If these uses "naturally" occur at different flows (and thus at different times), capacity and conflict issues may be small. When there is "overlap," both groups use the river concurrently and are more likely to affect each other.

With boating identified as a potential use through the AW appeal and the Forest Service Appeal Response, it is important to assess how often boating might occur. Comparable information for other flow-dependent recreation opportunities will show the "niches" occupied by other recreation activities on Upper Chattooga. When integrated with use information (see Chapter 4), this can help assess the potential impacts. Stakeholder discussion and the Sumter Revised LRMP (Appendix H) included assertions about boating and angling at different flows, but this information was imprecise and sometimes debated among stakeholders.

"Flow-dependent" recreation activities generally cannot occur at some flows, and their quality changes as flows change. In contrast, "flow-enhanced" activities such as hiking, camping, biking, wildlife observation and other riverside recreation usually occur regardless of flow, even though flows provide aesthetic benefits (Brown, 1991; Whittaker, 2002). Whitewater boating, angling, and swimming are the Upper Chattooga recreation opportunities most likely to be flow-dependent.

An extensive literature review documents techniques for assessing flows and recreation (Whittaker et al., 2006); the goal is to identify flow ranges for different recreation opportunities, often because flows can be manipulated by an upstream dam. For the free-flowing Chattooga, the goal is to learn when different activities are most likely to occur. The Forest Service developed information about Upper Chattooga hydrology and convened "expert panels" to assess flow needs for boating and angling in January 2007. Details are in a separate report (Berger, 2007c); summary information is provided below.

Chattooga hydrology

The Upper Chattooga (North Fork) sub-watershed has a relatively small drainage area (64 square miles) but receives considerable rainfall through the year, often in short but heavy storms. These storms produce a "flashy" hydrology where flows rise and fall quickly. During the summer (growing) season, substantial flow changes can occur within hours, although changes generally occur less rapidly during the winter (dormant) season. This flow regime affects the types of recreation that can occur.

Describing the Upper Chattooga's hydrology is challenging because the closest Chattooga gage (until recently) is at Highway 76, over 20 miles downstream from the end of the upper river. Hydrology information summarized below is based on analyses conducted by the Forest Service (Hansen, 2007); interested readers should review that report.

Understanding Chattooga River gages

- Hydrology information for the Upper Chattooga is primarily based on two gages:
  1. ***USGS Highway 76*** (No. 02177000); real-time gage updated every 15 minutes; period of record from 1940 to present; 21 miles downstream below the end of the Upper Chattooga.
  2. ***Burrells Ford*** data logger; collects water level data in 15-minute increments but must be downloaded manually; period of record beginning Jun 23, 2006; located in the middle of the Upper Chattooga, about 11 miles above Highway 28 and 10 miles below Grimshawes Bridge.
- Staff gages were also placed on Grimshawes Bridge, Bull Pen Bridge, and Highway 28 Bridge. Basic stage-discharge data were used to develop rating curves to allow future analyses at these locations. For the purposes of this report, the focus is on flows at Burrells Ford. Table 2 provides locations, basin sizes, and stage-flow conversion equations (when known).
- A gage was also recently installed on the West Fork Chattooga. It collects water level data from a data logger in 15-minute increments but must be downloaded manually. The period of record began April 14, 2007; the logger is located near Warwoman Road bridge. This may allow additional correlation between North Fork and West Fork flows, but insufficient data exists for use in this report.
- Initial analyses explored relationships between Burrells Ford, Highway 76, and other nearby USGS gages. The objective was to see if existing real-time gages could be used to estimate simultaneous flows at Burrells Ford, and whether the long record for Highway 76 could be used to describe the frequency of different flows at Burrells Ford. With sufficient overlapping data and analyses, the other nearby USGS gages may provide useful indicators of flow at Burrells Ford. Table 2 provides gage locations and basin sizes.

Table 2. Gages on or near the Upper Chattooga River.

Gage Location	Type	Basin size (square miles)	Stage-flow conversion
Chattooga Grimshawes Bridge	Staff	8	In development.
Chattooga Bull Pen Bridge	Staff	23	In development.
Chattooga Burrells Ford	Staff + data logger	47	Flow = 169.3 x stage$^{1.93}$ R^2 = .99
Chattooga Highway 28	Visual staff	64	Flow = 62.6 x stage$^{2.02}$ R^2 = .97
Chattooga Highway 76	USGS	207	Provided by USGS.
Cullasaja near Highlands, NC	USGS	19	Provided by USGS.
Davidson near Brevard, NC	USGS	40	Provided by USGS.
Talullah near Clayton, GA	USGS	57	Provided by USGS.
French Broad at Rosman, NC	USGS	68	Provided by USGS.

- Although we have less than one year of data to develop "simultaneous flow" relationships, analyses suggest the following:
  - Simultaneous flows at Highway 76 and Burrells Ford are moderately to highly correlated ***during non-storm periods*** and accurately "translate" between the two locations.
  - Simultaneous flows at Highway 76 and Burrells Ford have a lower correlation ***during storm events***, so "translations" should be used with more caution. This appears mostly due to timing (rain raises flows at Burrells Ford, but those flows take time to travel downstream to Highway 76). For some storms (particularly in summer), flow differences may also be due to localized storm cells that have larger effects at Burrells Ford but smaller effects at Highway 76.
  - Comparing across five gages in the area ***during storms***, the Highway 76 gage was generally the worst predictor of simultaneous flows at Burrells Ford (the Cullasaja was the best). During any particular storm, these nearby gages differed substantially. Although additional data and modeling could be used to improve estimates, installing a USGS-caliber gage at Burrells Ford is simpler, direct, and more accurate.
- Although Highway 76 data have limitations for predicting simultaneous flows at Burrells Ford, they can be used to assess the times when certain flows are likely to occur in an average year. The water in the Burrells Ford drainage area is well represented by the Highway 76 hydrograph even though the short-term timing during storms has lower correlations.
- It is possible to develop "translations" between the two gages so evaluations of flows based on one gage can be compared to evaluations at the other. This is important because most anglers are "calibrated" to the Highway 76 gage (which is highly correlated for the lower flows anglers tend to fish), while boaters (during the expert panel) made evaluations based on flows at Burrells Ford.
- Some boaters are accustomed to using one or more other gages when trying to estimate flows. Due to its proximity and smaller drainage area, the Cullasaja gage is probably the best gage for estimating whether flows in the Upper Chattooga are rising or falling during storm events.
- Regression analyses that "translate" flows between the two Chattooga gages are shown in Figure 9 and Table 3. Separate regression lines are shown for storm (initial response extended from peaks + 48 hours) and non-storm periods, and for summer (June to September) and fall/winter (September through March). We also report variance explained by the regression equation (the R^2 value); higher values show stronger relationships (a perfect correlation explains 100% of the variance).

Table 3. "Translating" flows between Highway 76 and Burrells Ford.

Period	Equation	R^2
Summer during storms	Flow at BF = 0.21 x (flow at 76) + 6	.56
Summer during non-storm periods	Flow at BF = 0.27 x (flow at 76) – 20	.71
Winter/fall during storms	Flow at BF = 0.33 x (flow at 76) + 18	.63
Winter/fall during non-storms	Flow at BF = 0.31 x (flow at 76) – 6	.93
Comparing peaks	Flow at BF = 0.48 x (flow at 76) – 37	.90

- In general, summer flows at Burrells Ford are about 27% of Highway 76 flows when it is not raining (dictated primarily by sub-surface inputs). During and just after summer storms, flows at Burrells Ford are about 21% of Highway 76 flows.
- In general, fall/winter flows at Burrells Ford are about 31 to 33 % of Highway 76, with little difference between storm and non-storm periods (although the relationship during storms has more variance).
- The precision of "translations" is considerably better during non-storm periods; storm cells introduce "noise" into the system. This "flashy" hydrology is common in headwaters streams. It is relevant for recreation because higher flows associated with storms are hard to predict and available for relatively short periods of time. This makes it hard for recreation users to use or avoid them.
- A separate analysis of storm peaks is shown in Figure 9. In this analysis the timing differences between the gages were removed and the explained variance increased, supporting the notion that timing causes variation between Highway 76 and Burrells Ford.
- For the 27 storms in this analysis, Highway 76 peaks averaged 8.3 hours after Burrells Ford peaks. For larger storm events (peaks over 900 cfs at Highway 76), the difference averaged 5.8 hours (because larger storms cover a wider area and tend to track from the southwest).
- During storm events, peaks at Burrells Ford are about 48% of peaks at Highway 76. This suggests that peaks at Burrells Ford rise and fall more quickly than those at Highway 76. This "attenuation" of downstream peak flows is common to many streams; headwaters are more flashy than the lower river.

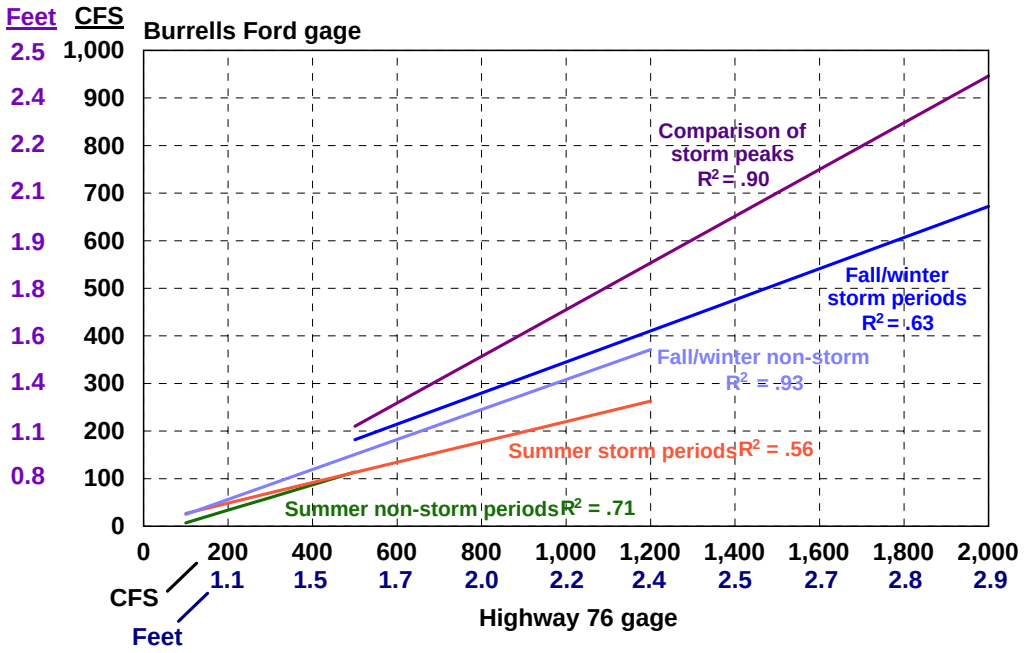

Figure 9. Relationships between Burrells Ford and Highway 76 gages.